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ABSTRACT

The author describes her career development from mathematics instructor to director of institutional research at a large community college. She discusses the impact of mathematics on her career, illustrates her present job by describing three recently completed research projects, and strongly recommends that mathematics instructors encourage some of their students to consider careers which use mathematics as a tool. Her descriptions of institutional research projects to determine demographic characteristics of the community college area, local labor market needs, and local consumer market preferences would be useful to any institutional researcher. Appendices include the charts, tables and narrative findings that resulted from her research on demography, as well as complete mathematical formulas for projecting populations through modified cohort procedures, two-point and multiple-point linear regression, and two-point and multiple-point logistic curves. (DC)

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EDUCATIONAL RESEARCH AND PLANNING AS A CAREER
OPTION FOR A MATHEMATICS MAJOR

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North Central Section Meeting
Mathematics Association of America
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TABLE OF CONTENTS

	<u>Page</u>
I. Introduction.	1
II. Demographic Activities.	4
III. Career Needs Assessment	9
IV. Market Research	11
V. Conclusion.	12
APPENDIX A. Selected demographic data and logistic curves. . .	14
APPENDIX B. Respondent characteristics for two survey techniques and two incentive methods.	30
APPENDIX C. Selected JCCC Research studies	33

EDUCATIONAL RESEARCH AND PLANNING AS A CAREER
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I. INTRODUCTION

Twenty years ago, I was a senior at Carleton College. While there, I attended some meetings of this group, but never imagined that I would be invited sometime as a speaker.

As I look back to those years at Carleton, I have only recently become aware of their influence on my career development. I was fortunate as a freshman to be in classes taught by Kenneth May and Frank Wolf. Since I came from a small town high school, I had many concerns as I began my mathematics classes. Both Kenneth May and Frank Wolf continued to encourage me throughout the years at Carleton. I can remember as a junior asking Kenneth May whether I would be the grader for the differential equations course the following year. He let me be the grader and I was delighted because the competition at Carleton was tough. Some of you know Roger Kirchner, who is now on the faculty at Carleton, and he is an example of that "competition." There were 11 mathematics majors in our class and I believe that 7 of those 11 now have doctorates.

The spirit among the students as far as assisting each other in understanding mathematical concepts was also a positive influence. Those who grasped the concept immediately were always willing to elaborate to the others. The faculty also promoted this peer interchange by encouraging those students interested in finite differences to conduct their own seminar. We met weekly and a presentation was made on the material by one of the group. No faculty were present and the interchange that took place during those meetings was excellent training for future teaching.

I left Carleton to go to the University of Kansas where I got my Master's. I must admit that my background at Carleton made it possible for me to put a lot of my time and energies into social activities. You must remember that the era of the 50's emphasized marriage. Although I planned a career, I realized that socially it would be more acceptable for me to be married. (Fortunately, I married a jewel of a person.)

From there my husband and I went to the University of Hawaii where I taught as a member of the mathematics department for four years. Along the way, I taught mathematics in several National Science Foundation Institutes. One particularly exciting institute was conducted in Chofu, Japan, for secondary teachers of military dependents in the Far East.

While in Hawaii, I became increasingly aware that I was growing dissatisfied teaching mathematics. As a result, I began seeking applications and took several courses in genetics. For a while, I thought that might be the "answer", but my husband's work began evolving into the area of educational research and the two of us became aware that my mathematical background and his background in psychology were assets in the emerging fields of Educational and Institutional Research.

Currently, I am the Director of Institutional Research at a large two-year community college in suburban Kansas City. Other than the University of Kansas, Kansas State University and Wichita State University, we have the largest freshman and sophomore enrollment in the State of Kansas. I also serve as a member of the Technical Advisory Committee

to the Kansas State Legislative Educational Planning Committee (1202 Commission).

What I would like to convey to you today is three fold. One is what influence mathematics had on my career as I made the transition from teaching college mathematics to educational research. Secondly, I plan to use three recently completed projects to illustrate what we do in our office. Last, I would like to have you leave today realizing that mathematicians must encourage some of their students to consider a planning career which uses mathematics as a tool. Otherwise, planning will be done by those unskilled in mathematics.

You may be surprised to learn that I consider my foundations of mathematics course taken as a junior from Frank Wolf as one of my more valuable courses. The reason is that I began to understand how to solve problems which seem initially very difficult. My fascination with concepts of infinity continued into graduate school where I did a thesis on Zermelo's Axiom of Choice. My thesis was not particularly good, but I do think the experience I gained provided excellent background for problem solving.

While at Carleton, I also took courses in probability and statistics and logic. When I went to graduate school, I was one of the few mathematics graduate students with previous coursework in those areas. I taught algebra, trigonometry and calculus while a graduate teaching assistant, but I also graded papers for both a logic course in the Philosophy Department and a probability and statistics course taken by many of my fellow graduate students. Grading for those courses sharpened my skills in both areas, but unfortunately I did not realize at the time how important they would eventually be for me. I also had taken modern algebra at Carleton so I

enrolled in some more symbolic logic plus a course on recursive functions. Just passing the latter course was a benefit to my thinking processes.

I had my first real encounter with modeling while I was at the University of Hawaii. A colleague whose speciality was statistics was very excited about mathematical modeling and tried to get me interested. I did begin to appreciate some of the ideas when I took a graduate course in population genetics.

In addition to my mathematics background, I somehow learned to write intelligibly. To have a career in educational research requires the ability to write and communicate effectively. I find increasingly that many concepts which may appear obvious and elementary to a person with a strong mathematical background are sometimes more useful than complex concepts. To be able to identify those simple ideas and communicate them to those who are decisionmakers is becoming extremely important. A brilliant idea may be lost because the decisionmaker did not understand it. Perhaps an adaptation would have been understood and resulted in desirable action by the decisionmaker.

II. DEMOGRAPHIC ACTIVITIES

I think my work in demography during the last six years can be used to help illustrate what I've referred to. When we began our work, we had some grandiose ideas about the model to develop. Our philosophy basically was that it was impossible for us to predict the future population for an area. However, given a set of assumptions with some alternatives, it was possible to project population for each of the alternatives.

Computer Model

We developed a model which allowed alternative assumptions about birth rates, death rates, net migration, and land use. The only way a population for a given geographic area can change is by births, deaths and net migration. Knowing the population at a beginning time t plus the number of births, deaths, people moving out and people moving in for the next year enables the simple arithmetic calculation of the population one year later.

$$P_{t+1} = P_t + (B_t - D_t) + (M_{in} - M_{out})$$

Where P_t = population at starting year t

B_t = number of births during year t

D_t = number of deaths during year t

M_{in} = in-migration during year t

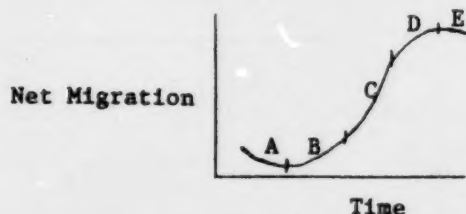
M_{out} = out-migration during year t

Although this equation is simple, the problems are to estimate births, deaths and migration. We developed regression equations to predict deaths by age and sex and to predict births by age of women. The difficulty with using the regression equations was that they assumed current trends would continue.

Therefore, we added the capability to specify a modification to the regression equation. To avoid making it too complicated, any modification had to be linear. (The regression equations themselves were not linear.) For example, our 1974 publicly released projections were based on three sets of assumptions. Basically we provided a low estimate, an estimate based on current trends and a high estimate. The low estimate used the regression equation for birth rates as a function of women's ages but also

assumed that those rates would linearly decline 20 percent by the year 2000. The high estimate used the same basic regression equation but assumed those rates would linearly increase to 1970 rates. Mathematically, the procedure is the specification of an initial year multiplier and an ending year multiplier. The multipliers for the intervening years are then found by fitting a straight line through the two points determined by the initial year and multiplier together with the ending year and multiplier.

Migration was our major problem. Since there was no practical way to determine how many people move into an area and how many move out each year, we limited ourselves to net migration - the difference. After examining the data, five net migration patterns representing five stages of land development were designated "A" through "E" on the population S-curve below.



These five stages may be described as follows:

- A. Agricultural - undeveloped in terms of potential population capacity. During this stage there is a net out-migration typical of most rural areas today.
- B. Initial transition from rural to urban/suburban accompanied by a shift from out-migration to in-migration.
- C. Maximum rate of development. During this state in-migration greatly exceeds out-migration.

- D. Reduced rate of growth. As the area approaches maturity the rate of net in-migration begins to decline.
- E. Maximum development. The available land is essentially fully utilized. During this state, there is a gradual shift from in-migration to out-migration.

There was no great difficulty in determining the current net migration stage for a particular land area. However, the projections required the selection of the net migration stage for the final year. In addition, two large land areas might overall be in the same net migration stage but have different limitations for total population capacity. The reason is that zoning influences the capacity (maximum number of people who could ultimately reside in the land area on the basis of current zoning). Thus, population could not exceed the total capacity. For example, suppose a land area has a 1970 population of 15,000 people. The typical cohort survival model might project a population of 22,000 in 1980 and 40,000 in the year 2000. However, if the land is primarily zoned low density residential, a maximum realistic population might be 29,000.

Significance of Results

Since 1972, we have supplied population projections to five of the six public school districts in the county. When our first projections were made, we projected school enrollment declines in two districts and increases in four districts. Each fall the enrollment data continue to support the original projections. On pages 14 through 20 are some graphs which illustrate the growth patterns in Johnson County. On pages 15 and 17 are two graphs summarizing data for the State of Kansas. The net migration patterns are quite dissimilar. However, note that the birth rate graphs have similar patterns. In addition, the natural increase component (births minus deaths) of population growth seems to be somewhat similar for both the county and the state.

Although we conjectured back in 1972 that the decline in birth rate would soon cease, the general national trend seemed to be to lower population projections. Yet, I note increasingly that some demographers are indicating that they think the birth rate decline may be ending. The main reason why we were bold enough to state that in 1972 was that there appeared to be some identifiable historic patterns which justified such an assumption.

During the era of rapid growth there was a tendency to do straight line projections and assume that growth would continue. In an era of decline, there may be a tendency to over-react and assume declines will continue.

During the last few years, I have also become increasingly aware that there is a need for accurate historical population data compiled in a readable format. As a result, I began printing and selling a booklet about population growth in Johnson County. This year is the second year we have made the booklet available and our first printing sold out entirely. The concept is quite simple--yet the material is in great demand and can be used by a variety of agencies. As one example, an area hospital planning to expand its facilities requested me to make a presentation about the projected population growth in the hospital's service area. Other examples of uses include fire station site selection, grant applications, church membership and program planning, and size determination for a county juvenile facility.

The population projections made in 1972 and updated in 1974 have been useful and influenced a number of area decisionmakers. Frankly, however, I think the greatest contribution made to the community is the availability of accurate data in a readable format. The printed booklet has, I think, had more broad significant effects faster than any sound projections based

on mathematical theory. One reason may be that there are many people who have their own opinions about what the future may bring, but they can't dispute the historical data.

III. CAREER NEEDS ASSESSMENT

Before a new career program can be initiated at JCCC, documentation must be provided that jobs are likely to exist in Metropolitan Kansas City for graduates of the program. Programs such as commercial art have presented some unusual problems. Nationally, the outlook for commercial artists has not been considered encouraging. However, the art staff at JCCC felt strongly that there were opportunities in the Metropolitan Kansas City area for graduates of a commercial art program.

One difficulty was that potential employers of graduates in commercial art are not as readily identified as employers in some other career areas such as nursing or data processing. Our office cooperated with the instructional staff. They did most of the work while we provided assistance with questionnaire development, sample selection, data aggregation, analysis of results and report preparation.

There were three phases to the study. Using the latest Contacts Influential (directory of companies by size, type, etc.) as a source, every (N=99) company with more than 500 employees was called to see if they hired commercial artists. Surprisingly (to us) these large companies were found to be unlikely sources of employment. Most were branch offices of larger national companies and any art work was done by, and sent from, the home office to assure uniformity in all art work.

The second phase was concerned with the identification of the types and numbers of smaller companies (11 to 500 employees) which hire commercial artists. There were 5,240 such firms listed in the Contacts Influential.

Three hundred companies were selected at random using a procedure I developed about five years ago for use with directories. Using telephone interviews to obtain the information, 267 companies were successfully contacted.

On the basis of Standard Industrial Classification numbers as published by the Bureau of the Budget, there was a great variety in the types of firms with artists on their staff. Since only a sample was selected, an estimate was needed of the total number of companies hiring commercial artists. One concern, however, was whether the sample firm sizes were similar to the population firm sizes. The Chi-squared statistic was used to determine whether the sample distribution could be considered representative of the population distribution. The obtained Chi-squared of 2.22 with four degree of freedom was not statistically significant ($p > .10$). The obtained data were used to estimate that there were about 491 companies (other than ad agencies and newspapers) hiring an estimated 923 commercial artists. In addition, approximately 2,295 firms did not have an artist on their staff but used art from ad agencies and free-lance artists. Thus, the employment possibilities were documented.

During the third phase, information was obtained from firms and commercial artists concerning what skills and training were needed by commercial artists. In addition, potential on-the-job training sites were identified as well as future company openings for graduates of a commercial art program.

The data and recommendations from all three phases were used in the development of a proposal for a career program in commercial art. As you might guess by now, the proposed program was approved by our Board

of Trustees and subsequently by the Kansas State Department of Education. The program has been successfully implemented.

IV. MARKET RESEARCH

About two and a half years ago, the Kansas City Star newspaper inquired whether our office was interested in developing a student conducted market research study of Metropolitan Kansas City. The purpose was to give manufacturers, distributors, retailers and advertisers current data on the products and brands purchased by families in the greater Kansas City area. The project seemed challenging and offered an opportunity for students to learn market research techniques for a project that would have results distributed nationally. The first contract had three phases (two mail surveys and one in-home survey) while the second contract had two phases which were both mail surveys.

The plan was to have students conduct all aspects of the project-- sample selection, mailing, questionnaire coding, keypunching, data processing, report preparation and typing. To date, students in marketing and management, data processing, secretarial studies, hospitality management, medical records technology and fashion merchandising have worked on the project.

When the project began, there was considerable concern that response rate to a mailed survey might be so low that the results would not be valid. Yet, the costs for in-home interviews were considerably higher. We decided to try some alternative strategies during the first year and use the results as a basis for determining techniques for future studies.

Mail surveys were conducted during the spring and fall with in-home interviews conducted during the intervening summer. Despite some expected seasonal variations, the results in all three surveys were very similar. All exceptions could be related to advertising strategy changes.

During the first mail survey, half of the questionnaires were mailed with a dollar bill enclosed as a token of appreciation. The other half had a statement in bold type on the first page which promised the respondents one dollar upon return of the completed survey by a specified date. Within two weeks, completed questionnaires were returned by 55% of those families receiving the dollar and by 29% of those promised the dollar. Respondent characteristics for the two survey techniques and two incentive methods were very similar (see page 30). Differences significant at the 0.10 level were that:

- 1) Males and the elderly responded more frequently when the dollar was enclosed than when the dollar was promised, and
- 2) a larger percentage of respondents promised a dollar referred to grocery ads than did respondents interviewed at home.

There was a higher percentage of non-working women respondents in the summer phase which utilized in-home interviews, but brand preferences during the summer phase were similar to both mail phases. Later surveys were conducted by mail and each questionnaire was sent with a dollar. The data could be obtained at a considerably lower cost and yet the results were comparable.

V. CONCLUSION

Those of you who are statisticians may have grimaced as I indicated the use of the 0.10 level of significance. Several years ago, I began to

question the emphasis on the use of the 0.05 level or less. I could understand the importance for circumstances where lives were at stake. However, educational decisions have not historically been based on the results of sound data analyses. The decisionmaker must frequently make decisions where some indication of trend is more important than being assured of a 0.95 confidence level. In fact, knowing that the 0.90 level of confidence was not attained can really be a stronger statement than to say the 0.95 level was not attained. Perhaps less emphasis on statistical technicalities and more emphasis on practicalities would encourage the use of sound data analyses by educators.

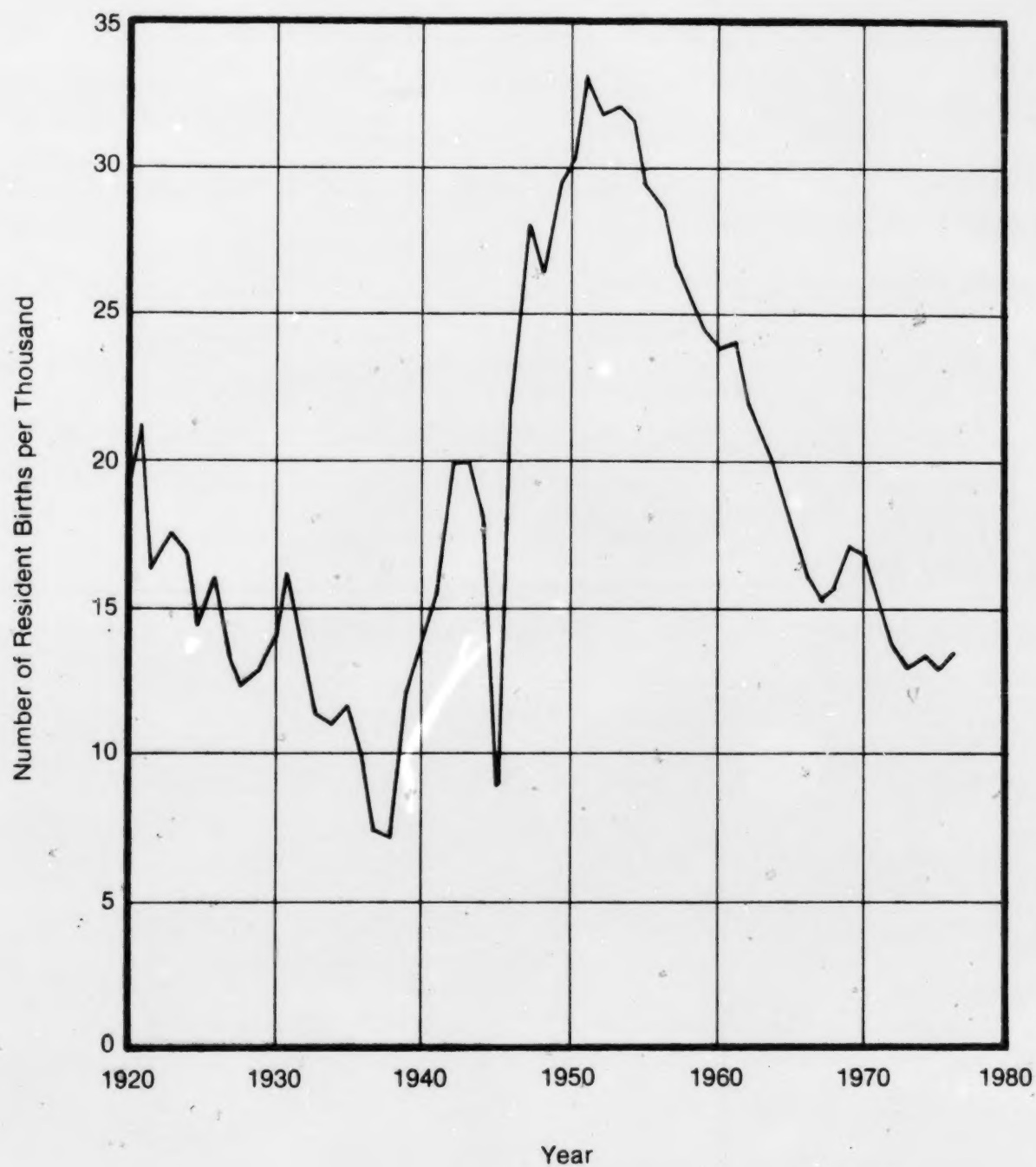
I would like to urge more persons skilled in mathematics to seek positions which relate to educational research and planning. The complex mathematical skills will not frequently be used directly themselves. They may be used "behind the scenes" but not released in full detail. The main value will likely be the application of the ability to think logically and abstractly. Also, encourage students to develop their abilities to write and speak clearly using simple terms. One page abstracts of a complex topic will usually have more direct impact than complete documentation of a project. Someday, I may even go back to teaching so that I can try to generate student enthusiasm for mathematics as a planning tool.

give you some idea of the type of projects we do in our office, I have attached a list of some of the major documents completed during the last few years. A number of our reports are available through the Educational Resources Information Center (ERIC) and the microfiche number is cited for such documents.

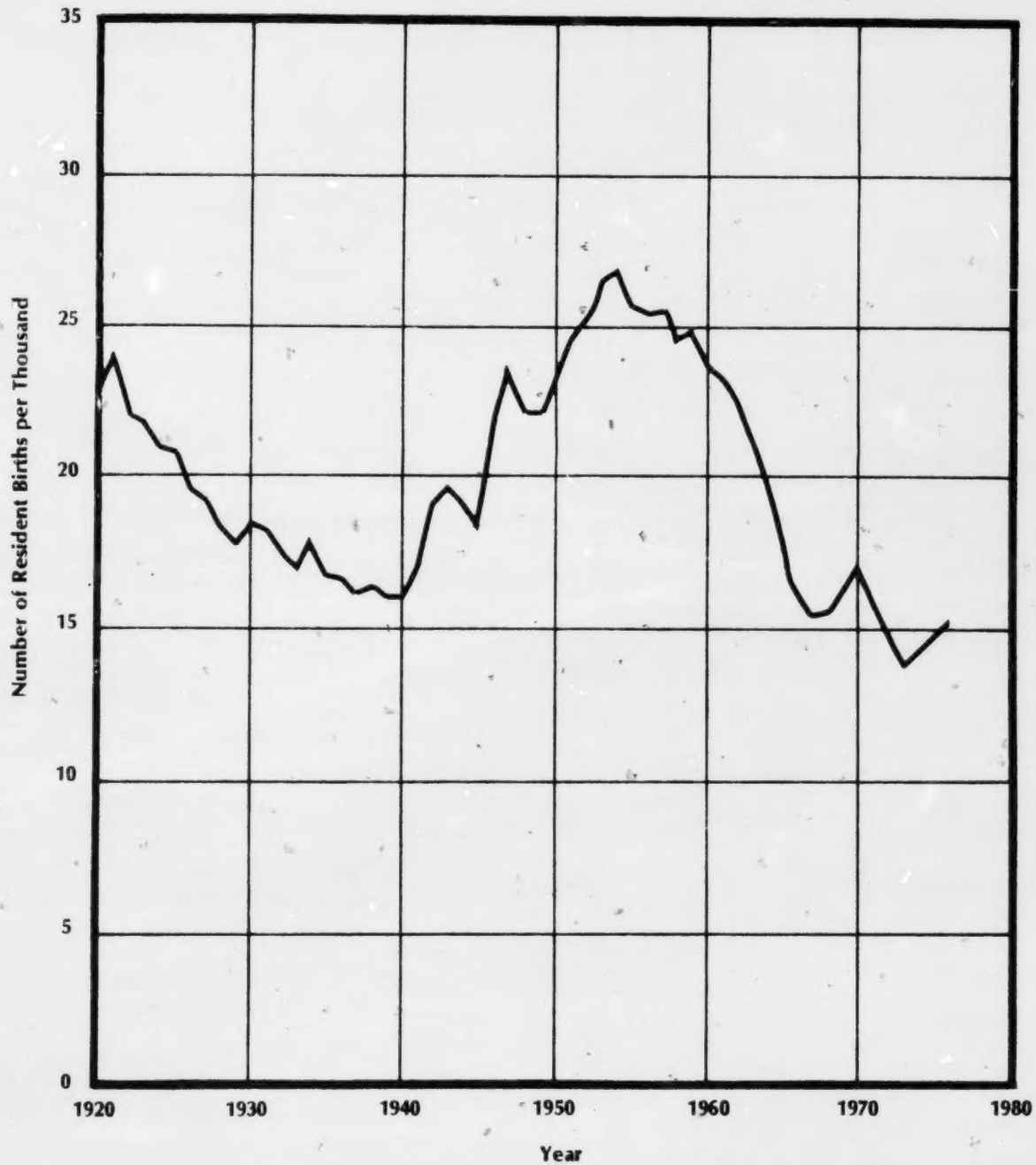
APPENDIX "A"

SELECTED DEMOGRAPHIC DATA AND LOGISTIC CURVES

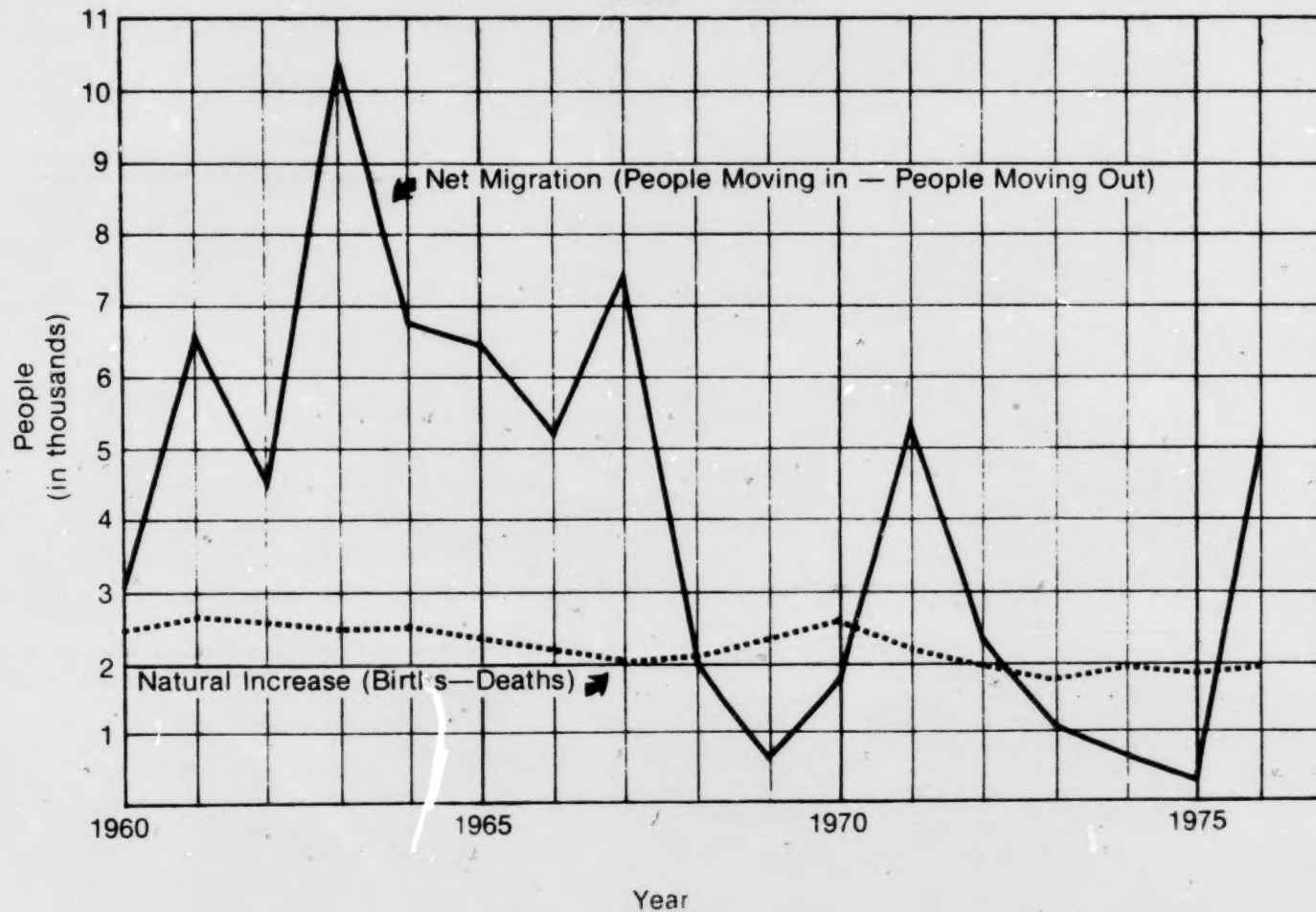
JOHNSON COUNTY BIRTH RATE



KANSAS STATE BIRTH RATE

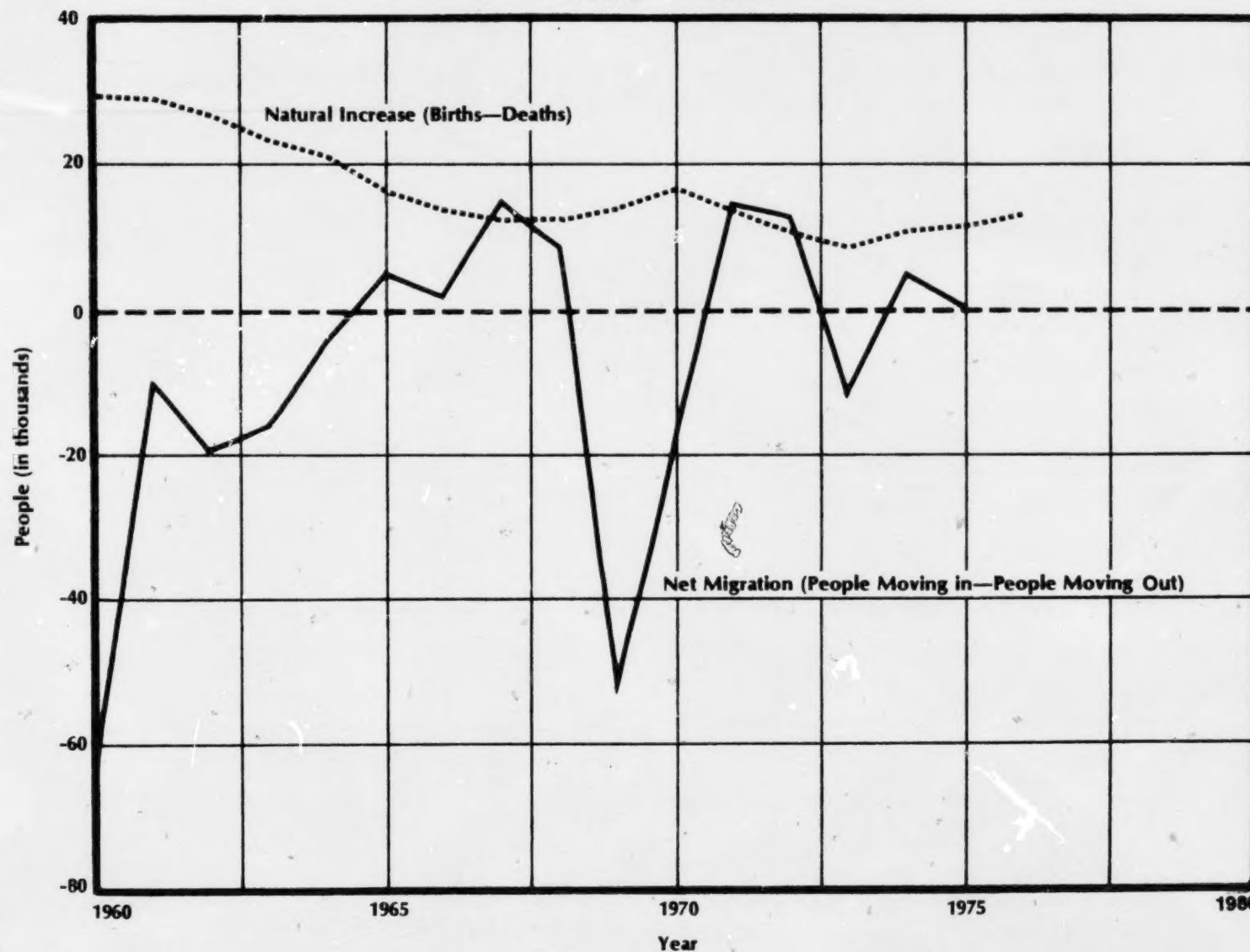


COMPONENTS OF POPULATION GROWTH FOR JOHNSON COUNTY 1960 - 1976

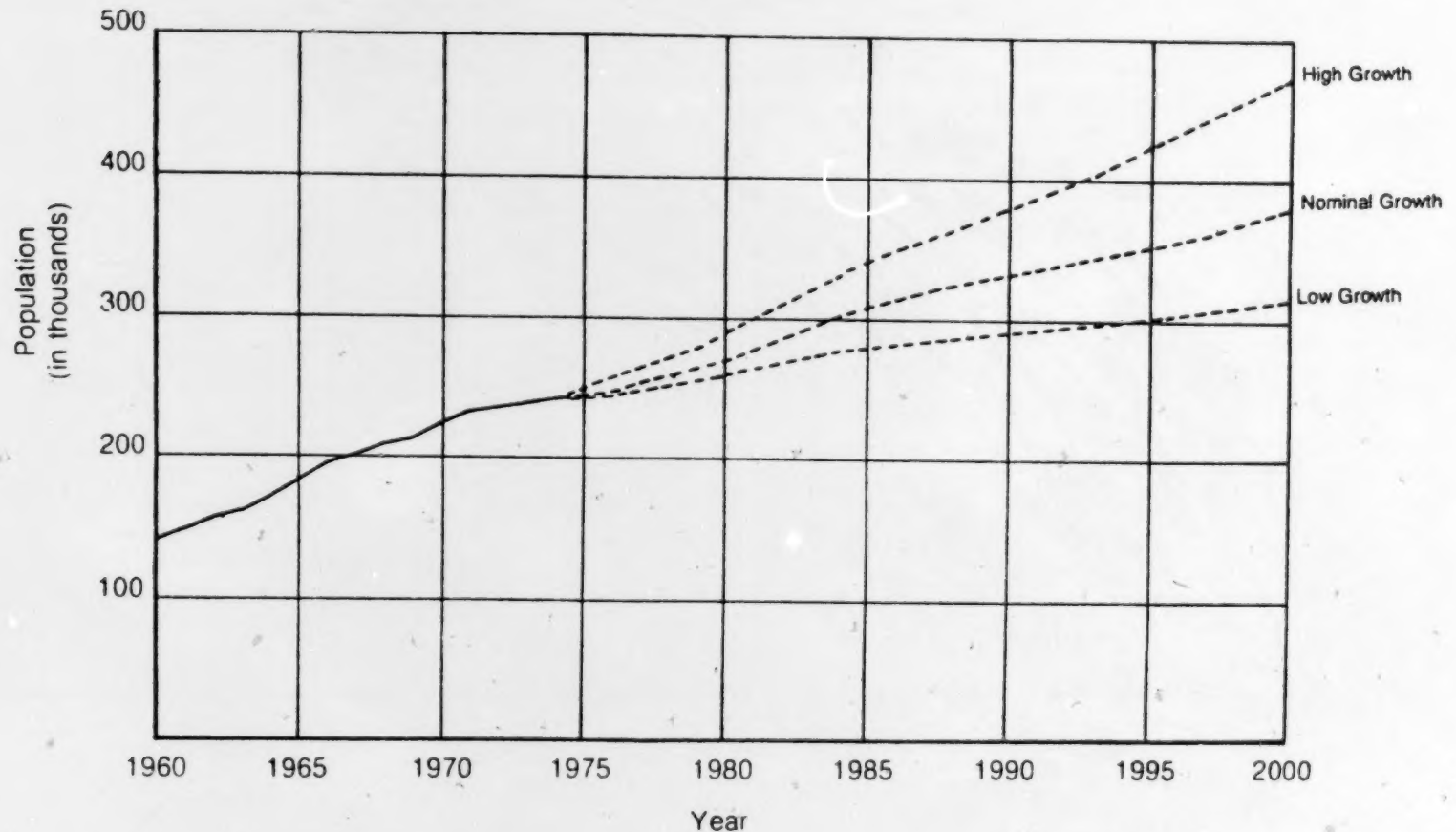


COMPONENTS OF POPULATION GROWTH FOR KANSAS STATE

1960—1976



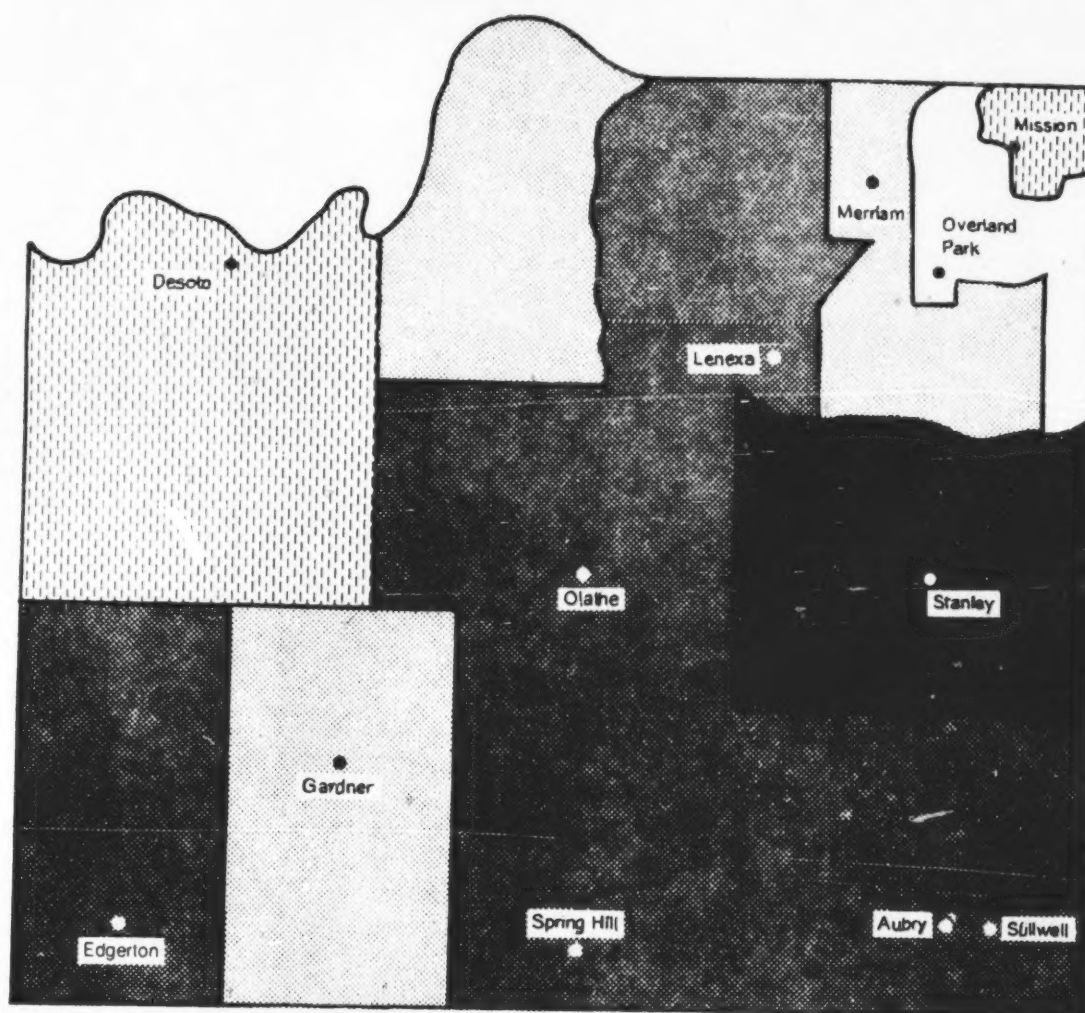
JOHNSON COUNTY POPULATION 1960 - 2000



A continued, but slowing rate of population growth is projected for Johnson County in the decades ahead. The County went from 141,694 residents in 1960 to 250,951 in 1977, an increase of 77 percent. In contrast, Johnson County will increase an additional 23 percent by the year 2000 if the birth rate continues to decline and net migration into the county continues at the 1973-1974 level. If, on the other hand, the birth rate does not continue to decline, the County population will increase 50 percent over the next 23 years.

POPULATION TEN YEAR FORECAST

Percent Increase Over 1973

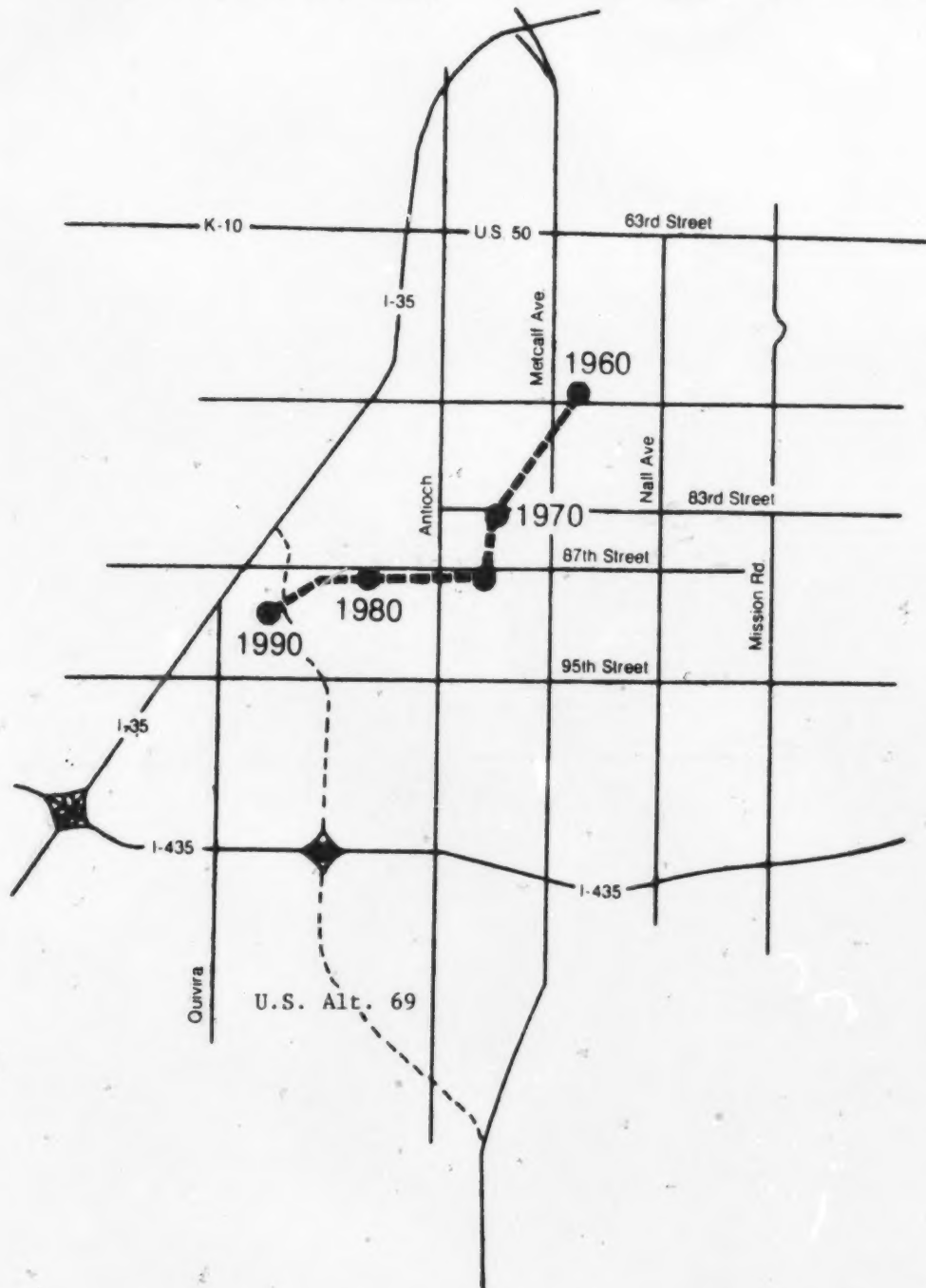


Percent Increase

- ▾ 0 - Declining
- ░ 0 - 10% Growth
- ▒ 10 - 50% Growth
- ▓ 50 - 100% Growth
- 100% or more Growth

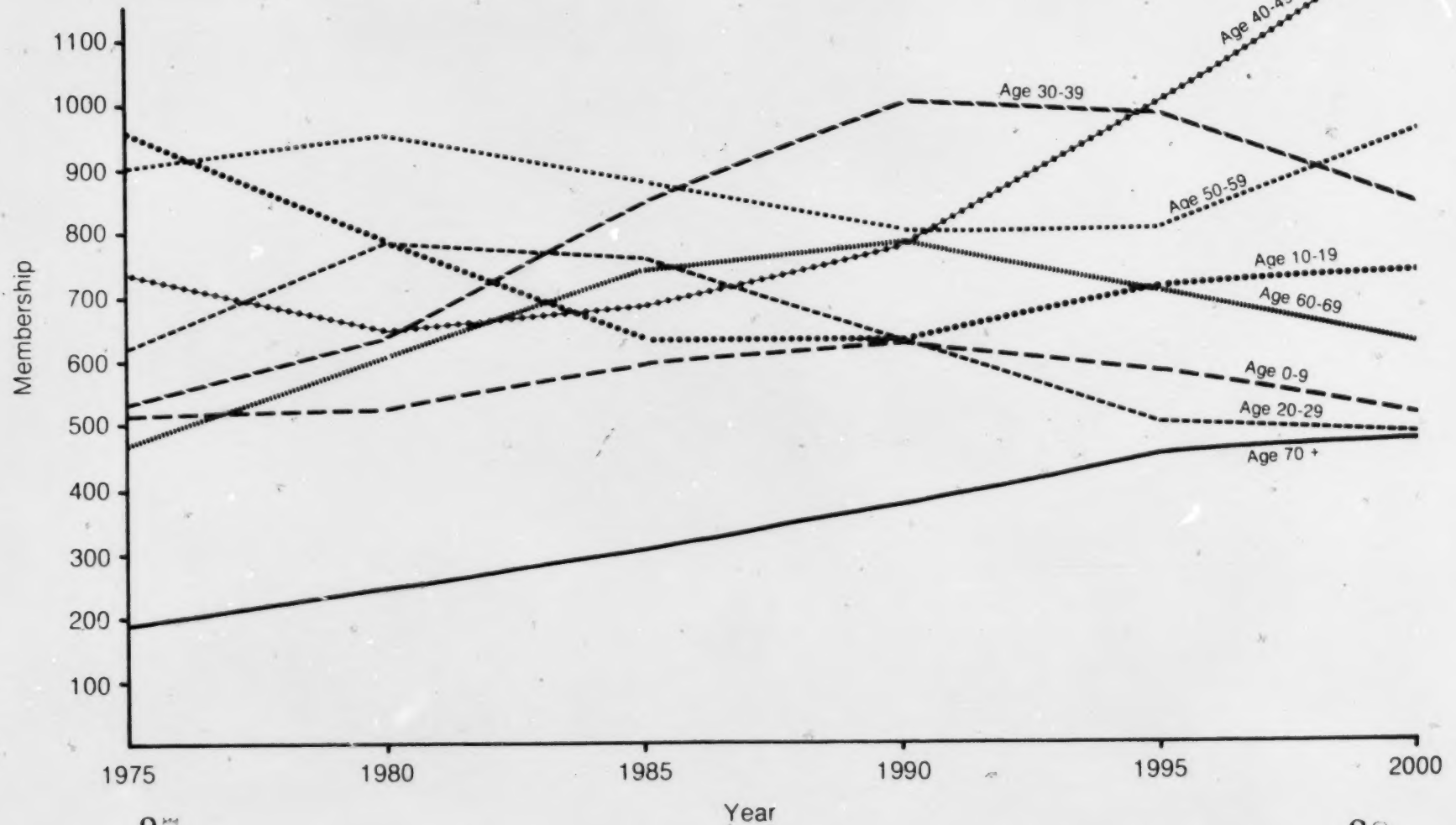
The demographic study completed by Johnson County Community College projects population for various areas of the County through 1983. Those areas located in the heavily shaded areas of the map are expected to have the largest population increases.

JOHNSON COUNTY POPULATION CENTROID



The center of population in Johnson County is moving south and west toward the communities of Olathe and Lenexa, according to the latest demographic study by Johnson County Community College. Located near 75th and Metcalf in 1960, the population center is expected to shift to 91st and Nieman Road by 1990.

PROJECTED SAMPLE CHURCH MEMBERSHIP FOR EIGHT AGE GROUPS 1975 - 2000



Hypothetical Illustration

Assume a fictitious county called Pirate County had a 1970 population of 300,000. The age and sex distribution is known for 1970. Equations have been developed for estimating births, deaths and net migration.

Illustration of Results

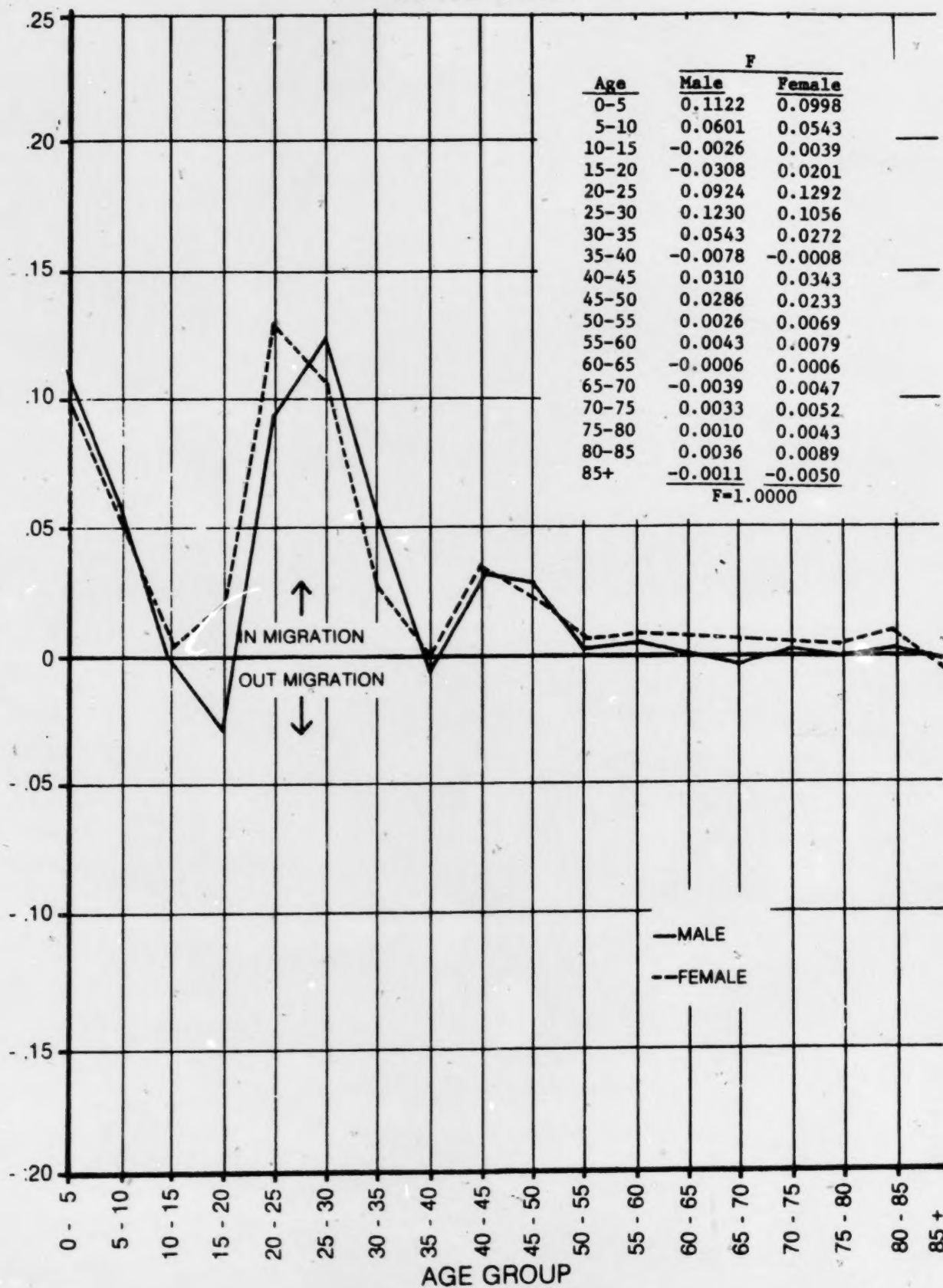
The county can be characterized as a growing community with a positive net migration and with the number of births approximately three times the number of deaths. The graph on the following page characterizes net migration by age group and sex. The table below summarizes the population projections for the year 1985 and the year 2000 under each of eight user alternative assumptions. The method used for the projections was a modified cohort procedure. As a comparison, examples using linear regression and logistic curves are presented on pages 23 through 29 .

PIRATE COUNTY POPULATION PROJECTIONS 1970 POPULATION WAS 300,000

User Alternative Assumptions	1985 Population	2000 Population
Zero Net Migration	363,616	414,249
Low Birth Rate and Net Migration	376,851	433,345
Low Net Migration	381,678	454,718
Low Birth Rate	412,561	511,139
Nominal	417,800	535,655
High Birth Rate	423,040	560,399
High Net Migration	453,924	616,594
High Birth Rate and Net Migration	459,576	644,495

PIRATE COUNTY

NET MIGRATION BY AGE AND SEX
F =



TWO-POINT LINEAR REGRESSION

$$Y = bX + c$$

Given two points (x_1, y_1) and (x_2, y_2) the equation is

$$Y = \frac{y_2 - y_1}{x_2 - x_1} (X - x_1) + y_1$$

Example

Using 1960 and 1970 Pirate County*population

Y = Projected population for year X

y_2 = 1970 population

y_1 = 1960 population

$$Y = \frac{300,000 - 180,000}{1970 - 1960} (X - 1960) + 180,000$$

$$Y = 12,000 (X - 1960) + 180,000$$

If $X = 1980$, $Y = 420,000$

$X = 2000$, $Y = 660,000$

*A fictitious county with the following historical population

P_{1900}	=	16,650	P_{1940}	=	39,000
P_{1910}	=	17,400	P_{1950}	=	75,000
P_{1920}	=	18,000	P_{1960}	=	180,000
P_{1930}	=	30,000	P_{1970}	=	300,000

MULTIPLE-POINT LINEAR REGRESSION

$$Y = bX + a$$

where Y is criterion

X is predictor variable

Given n pairs of observations for X and Y,

$$b = \frac{n \sum_{i=1}^n X_i Y_i - \sum_{i=1}^n X_i \sum_{i=1}^n Y_i}{n \sum_{i=1}^n X_i^2 - (\sum_{i=1}^n X_i)^2}, \quad a = \bar{Y} - b \bar{X} = \frac{\sum_{i=1}^n Y_i}{n} - b \left(\frac{\sum_{i=1}^n X_i}{n} \right)$$

Example

Using the population data for Pirate County, 1920-1970, the criterion Y is population while the predictor variable X is year,

$$n = 6, \quad \sum_{i=1}^6 X_i = 1920+1930+1940+1950+1960+1970=11670$$

$$\sum_{i=1}^6 Y_i = 18000 + 30000 + 39000 + 75000 + 180000 + 300000 = 642000$$

$$\sum_{i=1}^6 X_i^2 = (1920)^2 + (1930)^2 + (1940)^2 + (1950)^2 + (1960)^2 + (1970)^2 = 22,699,900$$

$$\sum_{i=1}^6 X_i Y_i = (1920)(18,000) + (1930)(30,000) + (1940)(39,000) + (1950)(75,000) + (1960)(180,000) + (1970)(300,000) = 1,258,170,000$$

$$b = \frac{6(1,258,170,000) - (11670)(642,000)}{6(22,699,900) - (11670)^2} = \frac{5688}{1.05} = 5417.14$$

$$a = \frac{642,000}{6} - 5417.14 \left(\frac{11670}{6} \right) = -10,429,337.30$$

$$Y = 5417.14(X) - 10,429,337.30$$

For X = 1980, Y = 296,600 which is less than actual 1970 population.

TWO-POINT LOGISTIC CURVE

S - shaped 

$$P_{t_1+\theta} = \frac{K}{1+e^{a+b\theta}}$$

Where P is population

t_1 is starting year

θ is number of years past starting year

K is holding capacity

Given K and P_{t_1} for year t_1

P_{t_2} for year t_2 , where $t_2 > t_1$

$$a = \ln\left(\frac{K-P_{t_1}}{P_{t_1}}\right) \quad b = \left[\frac{\ln\left(\frac{K-P_{t_2}}{P_{t_2}}\right) - a}{t_2 - t_1} \right]$$

Example

$$K = 1,500,000$$

$$t_1 = 1960, \quad P_{1960} = 180,000$$

$$t_2 = 1970, \quad P_{1970} = P_{1960+10} = 300,000$$

$$a = \ln\left(\frac{1,500,000-180,000}{180,000}\right) = \ln\left(\frac{1,320,000}{180,000}\right) = \ln\left(\frac{132}{18}\right)$$

$$= \ln\left(\frac{22}{3}\right) = \ln(22) - \ln(3) = 3.09104 - 1.09861 = 1.99243$$

$$b = \frac{\ln\left(\frac{1,500,000-300,000}{300,000}\right) - 1.99243}{1970-1960} = \frac{\ln\left(\frac{1,200,000}{300,000}\right) - 1.99243}{10}$$

$$= \frac{\ln(4) - 1.99243}{10} = \frac{1.38629 - 1.99243}{10} = \frac{-0.60614}{10} = -0.060614$$

$$\text{So } P_{1960+\theta} = \frac{1,500,000}{1+e^{1.99243\theta - 0.60614\theta}}$$

$$\text{For } \theta = 10, \quad P_{1970} \approx 300,000$$

$$\theta = 20, \quad P_{1980} \approx 471,000$$

Proof that a and b are obtained as specified on preceeding page for the logistic curve.

$$P_{t_1+\theta} = \frac{K}{1+e^{a+b\theta}}$$

At time t_1 , $\theta = 0$, $P_{t_1} = \frac{K}{1+e^a}$ so $P_{t_1}(1+e^a) = K$

$$P_{t_1} + P_{t_1}(e^a) = K$$

$$P_{t_1}e^a = K - P_{t_1}$$

$$e^a = \frac{K-P_{t_1}}{P_{t_1}}$$

$$a = \ln\left(\frac{K-P_{t_1}}{P_{t_1}}\right)$$

At time t_2 , $\theta = t_2 - t_1$ where $t_2 > t_1$

$$P_{t_2} = \frac{K}{1+e^{a+b(t_2-t_1)}}$$

$$P_{t_2} \left(1+e^{a+b(t_2-t_1)}\right) = K$$

$$P_{t_2} + P_{t_2}e^{a+b(t_2-t_1)} = K$$

$$P_{t_2}e^{a+b(t_2-t_1)} = K - P_{t_2}$$

$$e^{a+b(t_2-t_1)} = \frac{K-P_{t_2}}{P_{t_2}}$$

$$a+b(t_2-t_1) = \ln\left(\frac{K-P_{t_2}}{P_{t_2}}\right)$$

So $b(t_2-t_1) = \ln\left(\frac{K-P_{t_2}}{P_{t_2}}\right) - a$

And $b = \frac{\ln\left(\frac{K-P_{t_2}}{P_{t_2}}\right) - a}{t_2-t_1}$

MULTIPLE-POINT LOGISTIC CURVE

$$P_{t_1+\theta} = \frac{K}{1+e^{a+b\theta}}$$

Given year t_1 , capacity K and n observations, a and b are found so that the "best fit" is found. The procedure utilizes a transformation as follows:

$$P_{t_1+\theta}(1+e^{a+b\theta}) = K$$

$$P_{t_1+\theta} + P_{t_1+\theta}e^{a+b\theta} = K$$

$$P_{t_1+\theta}e^{a+b\theta} = K - P_{t_1+\theta}$$

$$e^{a+b\theta} = (K - P_{t_1+\theta}) \frac{1}{P_{t_1+\theta}}$$

$$a+b\theta = \ln \left(\frac{K-P_{t_1+\theta}}{P_{t_1+\theta}} \right)$$

$$\text{Let } Z = \ln \left(\frac{K-P_{t_1+\theta}}{P_{t_1+\theta}} \right)$$

$$\text{Then } Z = a + b\theta$$

Next, find the best linear fit for $Z = a + b\theta$, where $\theta = t_2 - t_1$

Example

Use the 1950, 1960 and 1970 Pirate County population data* together with a capacity of 1,500,000 people and a base year $t_1=1960$

$$\text{For 1950, } \theta = -10, Z = \ln \left(\frac{1,500,000-75,000}{75,000} \right) = 2.94444$$

$$1960, \theta = 0, Z = \ln \left(\frac{1,500,000-180,000}{180,000} \right) = 1.99243$$

$$1970, \theta = 10, Z = \ln \left(\frac{1,500,000-300,000}{300,000} \right) = 1.38629$$

$$* P_{1950} = 75,000$$

$$P_{1960} = 180,000$$

$$P_{1970} = 300,000$$

$$\sum_{i=1}^3 \theta = -10 + 0 + 10 = 0$$

$$\sum_{i=1}^3 Z = 2.94444 + 1.99243 + 1.38629 = 6.32316$$

$$\sum_{i=1}^3 \theta^2 = 100 + 0 + 100 = 200$$

$$\sum_{i=1}^3 \theta Z = (-10)(2.94444) + 0(1.99243) + 10(1.38629) = -15.5815$$

$$b = \frac{3(-15.5815) - (0)(6.32316)}{3(200) - (0)^2} = -.07791$$

$$a = \frac{6.32316}{3} - (-.07791)\left(\frac{0}{3}\right) = 2.10772$$

$$\text{So } Z = 2.10772 - .07791\theta$$

$$\text{Or } P_{t_1+\theta} = \frac{K}{1+e^{2.10772-\theta.07791\theta}} \text{ for } K = 1,500,000$$

$$\text{For 1980, } \theta = 20$$

$$P_{1980} = \frac{1,500,000}{1+e^{2.10772-1.55820}} = \frac{1,500,000}{1+e^{.54952}}$$

$$= \frac{1,500,000}{1+1.7324} = \frac{1,500,000}{2.7324} = 548,968$$

APPENDIX "B"

RESPONDENT CHARACTERISTICS FOR TWO SURVEY TECHNIQUES AND TWO INCENTIVE METHODS

Respondent Characteristics	Mail				Home Interview
	Respond in Two Weeks (Spring)		All Respondents Sent Dollar		Summer (N=406)
	Promised Dollar (N=125)	Sent Dollar (N=220)	Spring (N=281)	Fall (N=442)	
Female	91%	81%	83%	82%	83%
Age of Respondent					
18-24	12	6	7	9	10
25-34	26	23	24	25	28
35-49	28	25	24	26	25
50-64	24	29	27	26	17
65 and Over	10	17	18	14	20
Major Wage Earner in Family					
Man	77	79	78	68	71
Woman	21	20	21	19	19
Both*	1*	1*	1*	13	10
Work Status of Woman Respondent					
Full-time (30 hours or more)	42	35	34	38	19
Part-time or seasonal	11	9	9	9	10
Does not work	47	56	57	53	71
At Least One Other Person in Household					
Under age 2	13	7	9	11	10
2-5	22	17	17	18	20
6-11	26	26	24	23	24
12-13	11	14	13	12	14
14-17	21	17	16	19	18
18-24	23	19	18	17	20
25-34	26	20	21	23	24
35-49	29	25	23	23	23
50-64	20	26	23	23	18
65 and Over	4	14	15	12	17

*This option was not available during the spring phase, but some individuals wrote in "both." This option was included in the summer and fall phases.

RESPONDENT CHARACTERISTICS FOR TWO SURVEY TECHNIQUES AND TWO INCENTIVE METHODS
(continued)

Respondent Characteristics	Mail				Home Interview
	Respond in Two Weeks (Spring)		All Respondents Sent Dollar		Summer
	Promised Dollar (N=125)	Sent Dollar (N=220)	Spring (N=281)	Fall (N=442)	
Number of Children (under age 18)					
None	44%	51%	49%	48%	46%
One	20	16	19	21	22
Two	23	20	20	18	19
Three	10	10	9	8	8
Four or More	3	3	3	5	5
Number of Adults					
One	16	17	19	17	16
Two	58	58	58	67	63
Three	18	16	15	12	14
Four or More	8	9	8	4	7
Total People in Household					
One	13	13	14	10	9
Two	21	30	29	36	32
Three	24	17	19	19	21
Four	23	20	20	17	20
Five	13	10	9	11	9
Six or More	6	10	8	7	9
Annual Income Earned by All Members of Family Before Taxes					
<\$5,000	11	14	15	10	18
\$ 5,000 - \$ 7,999	13	12	12	11	15
\$ 8,000 - \$ 9,999	9	9	9	9	11
\$10,000 - \$14,999	27	25	24	24	25
\$15,000 or More	40	40	40	46	31
Amount Spent for Meat and Groceries (including milk) in Past 7 Days					
Under \$20.00	21	15	17	14	16
\$20.00 - \$29.99	23	23	25	24	24
\$30.00 - \$39.99	20	24	22	22	23
\$40.00 - \$49.99	12	18	16	20	13
\$50.00 - \$59.99	11	8	9	9	13
\$60.00 or More	13	12	11	11	11

RESPONDENT CHARACTERISTICS FOR TWO SURVEY TECHNIQUES AND TWO INCENTIVE METHODS
(continued)

Respondent Characteristics	Mail				Home Interview
	Respond in Two Weeks (Spring)		All Respondents Sent Dollar		Summer (N=406)
	Promised Dollar (N=125)	Sent Dollar (N=220)	Spring (N=281)	Fall (N=442)	
Someone in Family Made Purchase at Convenience Store in Past 7 Days	34%	35%	35%	39%	41%
Refer to Grocery Ads Received by Mail or Left at Door	80	76	78	**	58
Refer to Grocery Ads in Newspapers	85	76	77	70	68
Receive a Local Daily Newspaper in Home Regularly	72	77	73	77	74
Receive a Local Sunday Newspaper in Home Regularly	82	76	76	78	70

**Deleted from the fall survey instrument.

APPENDIX "C"

SELECTED JCCC RESEARCH STUDIES

The ERIC number is given for those documents available through ERIC.*

Educational Needs Survey of Johnson County, Kansas, 1969; May 1969

This study completed before the opening of the college, had two purposes: 1) to determine the needs and aspirations of the potential students of the College and 2) to determine the immediate and projected manpower needs of the industry, business and professional segment of Johnson County. The report provided realistic and detailed inputs into the curriculum and facilities planning efforts of the College staff.

Aviation Guidelines; 1971

These aviation guidelines were developed in partial response to the needs identified in an initial survey conducted by Johnson County Community College. The guidelines were designed to meet two fundamental needs: the need for insight, perspective, and basic understandings and the need for realistic, detailed program information. It pertains to the following program areas: Flight, Aviation Technology, Air Traffic Control, Aviation Administration, and Flight Service.

Planning and Development of Vocational Education and Services for the Hearing Impaired; July 1971 and several subsequent reports

A survey of the Kansas hearing impaired showed that they are inadequately prepared for the world of work and training opportunities are extremely limited. In a second survey, employers expressed the belief that vocational training would be of benefit to the hearing impaired. Upon completion of the feasibility study, the first hearing impaired students enrolled during the spring of 1972.

Student Attitude Toward the Audio-Visual-Tutorial Instructional Method; June 1972

At the request of Business and Science Division staff members, a study was initiated to assess JCCC student attitudes towards the AVT method of instruction in six classes. Three questionnaires were developed. Estimates of reliability ranged from .83 to .94. The findings of the report were used as a basis for six recommendations which were carried out by the instructional staff.

Number of Johnson County High School Graduates Attending JCCC 1972-73; August 1973 and updated yearly

The impact of a community college upon a community is illustrated via high school graduation information for students attending a county community college. For each high school in the county, the number and percentage of high school graduates attending JCCC are shown.

Follow-up Studies of JCCC Students, 1972-73; August 1973

The overall study consisted of five components: 1) Student Attitude and Value Study, 2) The General Class Profile, 3) The Career Student Follow-up, 4) Student Alienation Study and 5) Project "Quick Step" Enrollment Study. Students surveyed were at JCCC during the fall

*Educational Resources Information Center Clearinghouse for Junior Colleges at the University of California, Los Angeles.

semester of 1969 and 1971. Students surveyed in the Quick Step study were high school seniors simultaneously enrolled at JCCC during the spring semester of 1973.

Student Services Questionnaire; Fall 1973

The four components of the study were concerned with 1) student characteristics (e.g., career goals, number of hours working), 2) student opinion and useage of counseling services (e.g., types of assistance received from counselors), 3) student opinions of registration and other services and 4) student preference for additional course offerings.

Instructional Institutional Competitiveness Study, 1974-75; January 1975 and updated yearly

The fifth yearly study of the JCCC salary structure for instructional staff utilizes a procedure for comparing unscheduled instructional salaries with equivalent earnings on a local and regional basis. Summaries are included of supplementary information pertaining to leaves, work loads, summer school load and payment, part-time instructors, cost of living adjustments and fringe benefits.

1973 Career Student Follow-up: Initial Placement; January 1974

Three 1974 JCCC Career Student Follow-ups (ED 110 142); May 1975

1975 Career Student Follow-up: Initial Placement; April 1976 (ED 126 999)

Graduates and non-graduates with marketable skills were interviewed by telephone. Each student had been enrolled in one of the following eight career programs: secretarial skills, marketing and management, law enforcement, nursing, electronics, drafting, fashion merchandising, or data processing. The study included also some of the enrollees in the hearing impaired program. Information obtained included current job status, salary and opinions of their preparation for employment in their career program area. The April 1976 report also includes information on the dental hygiene career program and two in-service programs (basic police training and emergency medical technology).

Evaluation of College Learning Center Instruction in Six Subject Areas; January 1974

Evaluation of College Learning Center Instruction (ED 110 141); Spring 1975

The College Learning Center was created to provide individualized instruction to meet the varied needs of students. The purpose of the study was to determine whether the individualized instruction resulted in the improvement of specific learning skills. Descriptions of programs in spelling, vocabulary, English, mathematics, reading comprehension and reading rate are provided together with a description of the pretests and posttests. The results of the analyses of the pretest--posttest change have consistently indicated significant improvement in all six instructional areas.

Skills, Education and Experience for Clerical Staff: A Survey of Southern Metropolitan Kansas City Area Employers (ED 099 065); April 1974

Secretaries are currently very much in demand in the Kansas City area. Students leaving the program prior to graduation but with marketable skills were finding employment in secretarial fields. The question was raised as to whether employers wanted and were willing to pay for office staff with the skills of a Certified Professional Secretary. Opinions were obtained from employers of clerical staff as to what skills, education and experience were necessary or desirable for positions of clerk/receptionist, clerk/stenographer, secretary and administrative assistant. Under the direction of the research staff, students in the Secretarial Field Study class were trained in the basic methodology for conducting surveys. These students then conducted

personal interviews to collect the needed data. They also compiled the data under the direction of the research staff. The completed report did result in the development of a one year secretarial program.

Five JCCC Institutional Studies, 1973-74 (ED 099 070); September 1974

1. Community Satisfaction with JCCC Programs and Services
2. Continuing Education Student Profile
3. JCCC Student Success at Four-Year Transfer Institutions
4. Follow-up of Students Attending JCCC during Fall 1970
5. Library User Opinion of JCCC Library

Identification of Employers in Metropolitan Kansas City Who Hire Commercial Artists: January 1975

Employer Perceptions of Important Skills, Knowledge and Attitudes for Commercial Artists in Metropolitan Kansas City; December 1975 (ED 116 726)

The research staff provided assistance to members of the commercial art teaching staff in conducting a survey of Metropolitan Kansas City to identify non-obvious potential employers of commercial artists. A second phase study has involved the identification of skills, knowledge and attitudes which employers perceive as necessary to secure employment as a commercial artist. This latter phase has also involved identification of on-the-job training sites.

Community Response to Direct Mail from a Community College including an evaluation of a credit card plan; January 1976 (ED 121 384)

This report consisted of three major sections. One concerned the effect of direct mail and other means of advertising the continuing education/community service activities. A second was an analysis of the use of registration forms from various promotional materials as well as community opinion and utilization of the mailed bulletin. The third was an evaluation of a trial credit card plan for payment of tuition and/or course fees in continuing education/community service activities.

Credit Hour Enrollment, (by residency, sex for each career program and full-time/part-time students in addition to summaries for all career programs and total credit hour enrollment); Fall, 1975

Demographic Study of Johnson County, Kansas; October 1972

The demographic planning model was designed to predict population characteristics within the County taking into account possible future social, economic and political factors which could affect migration patterns as well as birth and death rates. A special capability afforded by the planning tool is its ability to analyze the scope of unpredictable trends.

Demographic Planning Workshop (ED 088 531); October 1973

In March 1972, Johnson County Community College initiated the development of a computerized demographic planning tool. Terminology and data analysis techniques are presented by using a fictitious county. Data are presented for five different subareas within the county. Samples of applications are included in the appendices. Included also are major elements of a community needs survey, a sample proposal, a sample study for hospital planners, sample study for church planners, and a section on historic and projected population data for Johnson County.

Village Presbyterian Church Membership Projections; October 1974

A large church with almost 5000 members was concerned with the future membership size and age distribution. Using an existing computerized model for population projections, membership projections by age were developed through the year 2000. The membership projections by age were also developed for each of 28 geographic areas with current members of the church.

A Computer Model for Demographic Projections in Educational Planning
(ED 101 786) November 1974

The postsecondary enrollment dilemma and a positive approach to dealing with the problem is illustrated by examining the situation at Johnson County Community College. The capability for long-range population projections was begun in 1971. It is possible for the JCCC planner to make detailed enrollment studies of feeder neighborhoods within the college's service area. Another of the model's useful features is its ability to provide for parametric analysis.

Declining Enrollments & Why? What are the Trends and Implications; September 1975 (ED 116 728)

Metropolitan Kansas City Food Products Survey; Spring, Summer and Fall 1975, Fall 1976.

A three phase Metropolitan Kansas City Food Products Survey began March 1975 as an instructional market research teaching device. Residents within the Kansas City Standard Metropolitan Statistical Area were surveyed about their food buying habits. The majority of the questions requested the brand names for 72 specified food products on hand. The Kansas City Star newspaper sponsored the project. Four hundred completed questionnaires were required for each of the three phases. Seven instructors and twenty-one students participated in a variety of ways, and were involved either directly or indirectly. Some conducted home interviews. Others did such things as sample selection, mailing, coding, keypunching, typing of final report, art work for the questionnaire and computer program development. A two phase up-date began September 1976.

Nursing and Dental Hygiene Selection Procedures. Part I: The Structural Interview as a Tool for Selecting Students into an Associate of Arts Degree Program (ED 116 727). Part II: An Examination of Academic Variables as Predictors of Success (ED 121 381); March 1976

Evaluation of Television Offerings, Fall 1975. March 1976 (ED 121 385)

Two commercially developed television courses, The Ascent of Man and Classic Theatre, were shown locally during the fall of 1975. JCCC granted three hours of credit to students who successfully completed a course. This report summarizes the opinions of students who returned a questionnaire concerning the specific course in which they were enrolled.

Part-Time Instructor Survey, April 1976 (ED 127 000)

As enrollment has increased, so has the number of part-time instructional staff. This study was conducted to collect demographic data about these instructors and to request their opinions on a few selected topics concerning their employment at JCCC and elsewhere.

The Mathematician's Role in Educational Planning (American Mathematical Monthly, February 1976, p. 131-2)

Employer Manpower Needs and Job Entry Requirements for Biomedical Equipment Technicians; June 1976 (ED 126 998)

This survey, primarily of metropolitan Kansas City, was designed to assess local manpower needs, obtain employer perceptions of the skills needed to secure employment in the field and to identify possible on-the-job training sites for students.

Population Growth Patterns for Johnson County, Kansas; July 1976

The number of county agencies which need county demographic data has continued to increase. This booklet summarizes the data requested most frequently and includes population data, birth and death data as well as net migration data for various areas within the county.

A Student Evaluation of Counseling and Library Service, Student Activities and College Publications (including student preferences for alternative class schedules); August 1976 (ED 126 997)

Students were surveyed during March 1976 and asked to provide demographic information as well as opinions on student services and selected aspects of instruction so that the effectiveness of the services could be examined for various segments of the student population.

Qualifications & Responsibilities for Nursing Instructors in Associate of Arts Degree Programs; Spring 1976 (ED 126 963)

CEEB Campus to Prospective Student Programs; Spring 1975 (ED 108 723)

Institutional Research: Resources and Suggestions; March, 1977 (ED)

Paper presented at Advanced Institutional Development Program Consortium Two Year College Grantee Workshop, Washington, D.C.

Employer Manpower Needs and Job Entry Requirements for Paralegals Within Johnson County, Kansas; April 1977

A survey was sent to all members of the Johnson County Bar Association and Kansas City Association of Legal Assistants. The purpose of the survey was to gain information about the local job market for paralegals, determine the types of skills potential employers would prefer, and identify individuals or firms who would consider providing work-study experiences for students.

Fringe Benefits at Fifteen Regional Colleges and Universities; June 1977

Compares JCCC fringe benefits to those offered at 14 Kansas and Missouri colleges and universities.

Relationship of JCCC Grades to Emporia State Grades for Seventy Transfer Students; June 1977

JCCC Graduate Trends, 1971-1976 (Characteristics and Impressions); July 1977 (ED)

All graduates of the college were mailed a questionnaire during summer 1977. The purpose was to determine trends among graduation classes with respect to demographic characteristics, opinions about JCCC and activities since graduation.

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